THE LACK OF POTASSIUM ISOTOPIC FRACTIONATION IN BISHUNPUR CHONDRULES. J. N. Grossman[1], C. M. O'D. Alexander[2], J. Wang[2], B. Zanda[3,4], M. Bourot-Denise[4], R.H. Hewins[3] and Y. Yu[3]. [1]U.S. Geological Survey, Reston, VA 20192. [2]DTM, Carnegie Institution of Washington, Washington DC, 20015. [3]Department of Geological Sciences, Rutgers University, Piscataway, NJ 08854. [4]Museum National d'Histoire Naturelle, 61 Rue Buffon, 7500 Paris, France.

Background: Volatile elements can provide some of the best constraints on the nature of the chondrule formation process and of chondrule precursors. Volatile-poor chondrules may have formed either from volatile-poor material, or by partial evaporation of volatile-rich material during melting. Volatiles may also have been affected by secondary processes, such as parent-body (aqueous) alteration of chondrules.

Rayleigh-type evaporative loss of K from synthetic chondrules produces rapid increases in $\delta^{41}K$, even at modest levels of evaporation [1]. In [1], the mesostasis in three low-FeO chondrules were analyzed, and none showed any resolvable (<2‰) fractionation of K isotopes. [1] assumed that entry of K into the chondrules after accretion was minimal and, therefore, that evaporative loss of K did take place, but probably in a dust-enriched environment, allowing isotopic exchange between gas and melt.

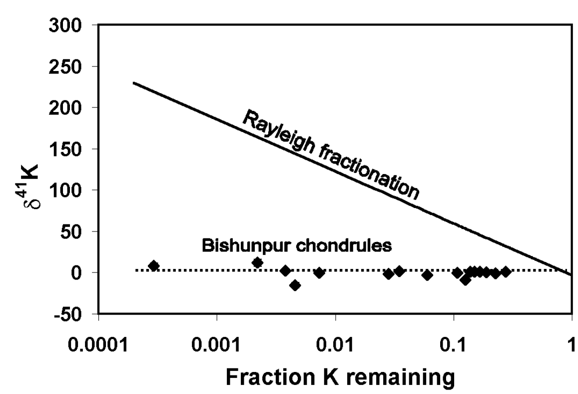
New studies: Here, we attempt to rule out that secondary entry of volatiles into chondrules erased evidence of primary K isotopic fractionation. We identified inclusions of glass inside olivine crystals in 6 Bishunpur chondrules. As in Semarkona [2], several of these inclusions have extremely low Na/Al ratios compared to their chondrule mesostasis. There is evidence that volatiles, including K, did enter certain chondrules after solidification, probably during aqueous alteration [3]. The glass inclusions, especially alkali-poor ones, offer the best hope of finding material that escaped any such alteration. These inclusions, as well as normal chondrule mesostasis were analyzed by ion probe as described in [1].

Results: Five of the chondrules were type I (olivine, Fa_{0-1}), with mesostasis Na_2O contents of 0.2 to 9 wt% (the latter being an unusual type I chondrule). The sixth chondrule had Fa_9 olivine and mesostasis with 2-4 wt% Na_2O. One type I chondrule and the sixth chondrule had glass inclusions that were significantly lower in alkalis than surrounding mesostasis.

The analysis of 17 areas of mesostasis and glass inclusions are plotted in the Figure. The fraction of K remaining assumes initial L-chondrite-like K/Al ratios for all the chondrules. None showed any significant K isotopic fractionation, confirming the results in [1].

Discussion: From the analyses, it seems likely that Bishunpur chondrules lacked any K isotopic fractionation even before parent body alteration occurred. This is consistent with direct condensation models of chondrule liquids [4], although we doubt that such models can explain many of the properties of real chondrules (e.g., relict grains, fast cooling rates). Type I chondrules could have formed from volatile-poor material such as high-temperature condensates, which would not be expected to show K isotopic fractionation, although the correlation of chondrule grain size with volatile content may argue against this [5] depending on the effect of secondary alteration. If type I chondrules did experience evaporative loss of volatiles, then the combined effects of enhanced evaporation rates due to fairly high P_{H_2} and exchange with the surrounding gas while molten must have reduced the amount of isotopic fractionation in chondrules to levels we are unable to detect. This does not require that volatiles recondensed into chondrules to any great extent during cooling: they were simply able to exchange with the melt. Indeed, the zoning profiles of glass in many type I chondrules requires that most observed secondary entry of volatiles happened after solidification and incorporation into a parent body.

What is now certain, however, is that chondrules did not experience simple Rayleigh-type loss of volatiles.



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